AD-12864-SPI LCD Module

User Manual

V1.0 – 2009.09

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REV.H

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1 General Description

1.1 Features

The AD-12864-SPI, a 128×64 dot matrix liquid crystal display module. It uses COG, integrated control unit, display memory and driver. AKIHABARA INC. designed special interface and fixed the row glass, backlight board and PCB with a metal frame, users can use it conveniently and easily.

- 128×64 dot matrix FSTN
- The duty ratio is 1/64, bias ratio is 1/9
- It uses sigle power
- Programmable contrast
- Only write SPI serial interface
- 3.3V white backlight

1.2 Electrical parameters

Table 1.1 Threshold parameters

Parameters	Symbol	Min	Max	Units
Supply voltage	VDD	-0.3	5	V
Input voltage	Vin	-0.3	Vdd+0.3	V
Operating temperature	Topr	0	50	℃
Storage temperature	Tstr	-20	60	℃

Table 1.2 Electrical parameters

Parameters		Symbol	Condition	Min	Typ	Max	Units
Supply voltage		Vdd	—	-	3.0	3.3	V
Input voltage	High Level	Vih	—	0.8Vdd		Vdd	V
	Low Level	Vil		Vss		0.2Vdd	
LCD supply voltage		Vlcd	—	-	3.0	-	V

1.3 Block Diagram

The block diagran of AD-12864-SPI LCD Module is shown in Figure 1.1.

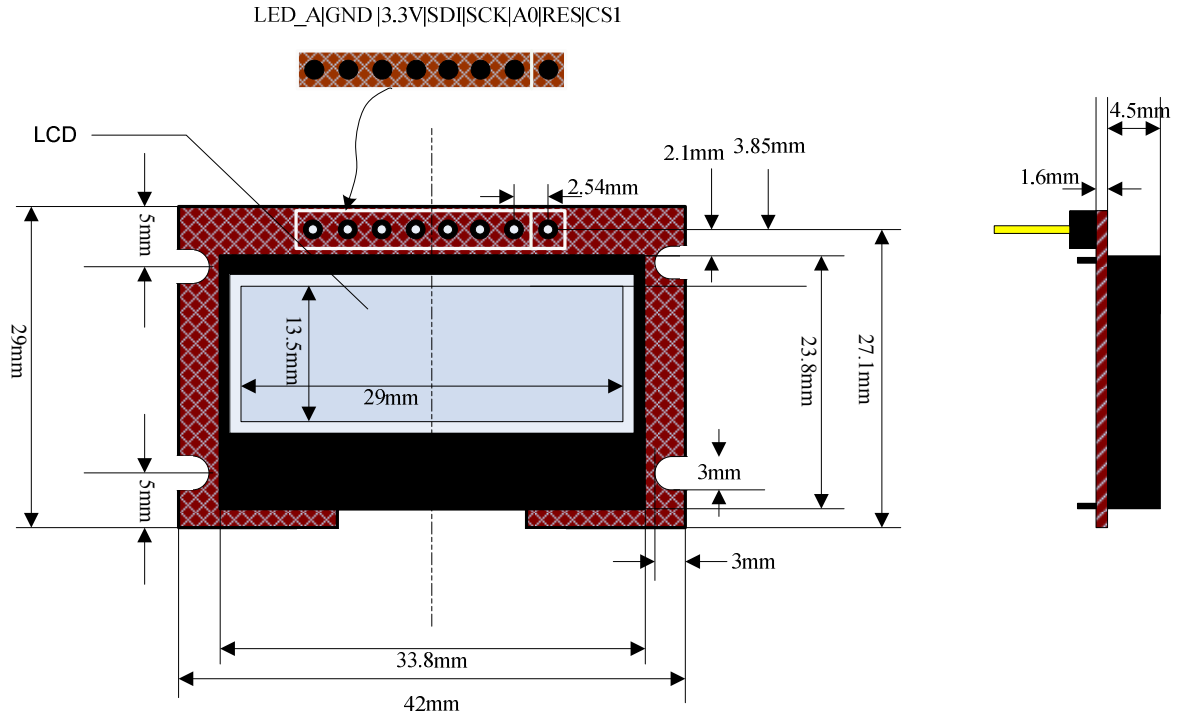


Figure 1.1 Functional block and size diagram

On the back of the module, there are 8 pin port, their function are shown in Table 1.3.

Table 1.3 Port function

No.	Symbol	Description
1	/CS1	This is the chip select signal. When /CS1 = “L” then the chip select becomes active.
2	/RES	When /RES is set to “L,” the settings are initialized. The reset operation is performed by the /RES signal level.
3	A0	It determines whether the data bits are data or a command.
4	SCK	SPI clock
5	SDI	SPI data
6	VDD	VDD, recommend 3.0V
7	VSS	GND
8	LED_A	Backlight LED

2 LCD Specification

2.1 Display Data RAM

The display data RAM of AD-12864-SPI LCD Module stores the dot data for the LCD, every dot data can display one corresponding dot in LCD. It has a 65 (8 page×8 bit +1)×132 bit structure. AD-12864-SPI LCD Module can display 64×128 pixel, so it only uses 64×128 bits RAM, if byte as its unit, there are 8 pages, each page is 8 columns, and each column is 128 bits.

One byte data of LCD driver IC RAM corresponds to the LCD display common direction, as Figure 2.1 and Table 2.1.

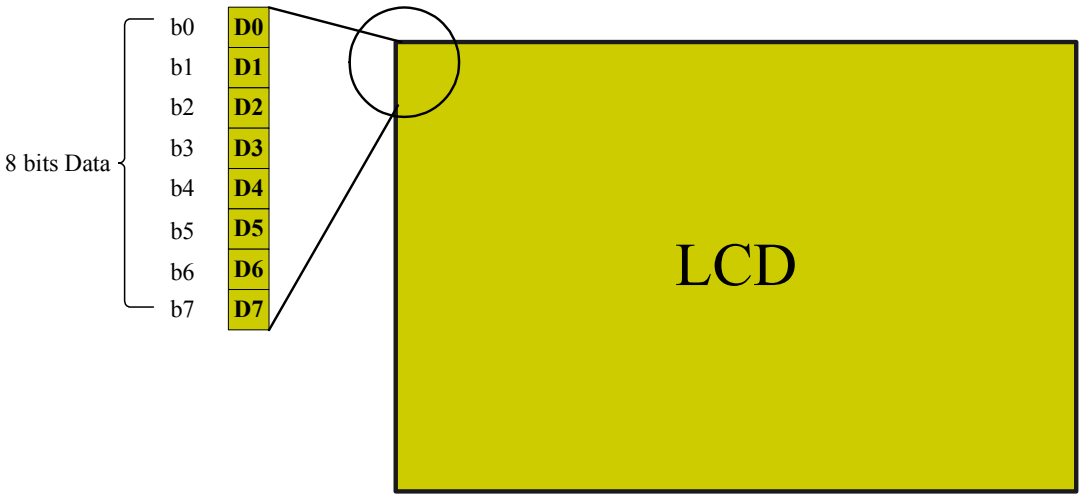


Figure 2.1 RAM data and LCD display diagram

Table 2.1 RAM data and LCD display diagram

			Com / Col	LCD x（From left to right）								
				0	1	2	3	……	……	125	126	127
LCD y （From top to bottom）	Page0	8bit data	0	bit0	bit0	bit0	bit0	……	……	bit0	bit0	bit0
			1	bit1	bit1	bit1	bit1	……	……	bit1	bit1	bit1
			2	bit2	bit2	bit2	bit2	……	……	bit2	bit2	bit2
			……	……	……	……	……	……	……	……	……	……
			6	bit6	bit6	bit6	bit6	……	……	bit6	bit6	bit6
			7	bit7	bit7	bit7	bit7	……	……	bit7	bit7	bit7
	Page1	8bit data	8	bit0	bit0	bit0	bit0	……	……	bit0	bit0	bit0
			9	bit1	bit1	bit1	bit1	……	……	bit1	bit1	bit1
			……	……	……	……	……	……	……	……	……	……
			15	bit7	bit7	bit7	bit7	……	……	bit7	bit7	bit7
	……		……	……	……	……	……	……	……	……	……	……
	……		……	……	……	……	……	……	……	……	……	……
	Page7	8bit data	56	bit0	bit0	bit0	bit0	……	……	bit0	bit0	bit0
			……	……	……	……	……	……	……	……	……	……

			59	bit7	bit7	bit7	bit7	……	……	bit7	bit7	bit7
			60	bit0	bit0	bit0	bit0	……	……	bit0	bit0	bit0
			61	bit1	bit1	bit1	bit1	……	……	bit1	bit1	bit1
			62	bit2	bit2	bit2	bit2	……	……	bit2	bit2	bit2
			63	bit3	bit3	bit3	bit3	……	……	bit3	bit3	bit3

2.2 Column and Line Address

As Figure 2.1and Table 2.1, when lighting a dot in LCD, first will need to know the column and line address, and find the corresponding bit, set it to 1. Because the AD-12864-SPI LCD module column address is independent of the page address, one page is 8 column. The line address is LCD x-coordinate, from left to right, one byte data correspond to one line in RAM, there are 128 lines in total.

Then, MCU can control LCD driver IC to control LCD display.

Note, the display RAM of AD-12864-SPI is more than LCD display need, users can refer the Demo to set proper patameters.

2.3 Operating Timing

AD-12864-SPI module has SPI serial interface, the write timing is shown in Figure 2.2.

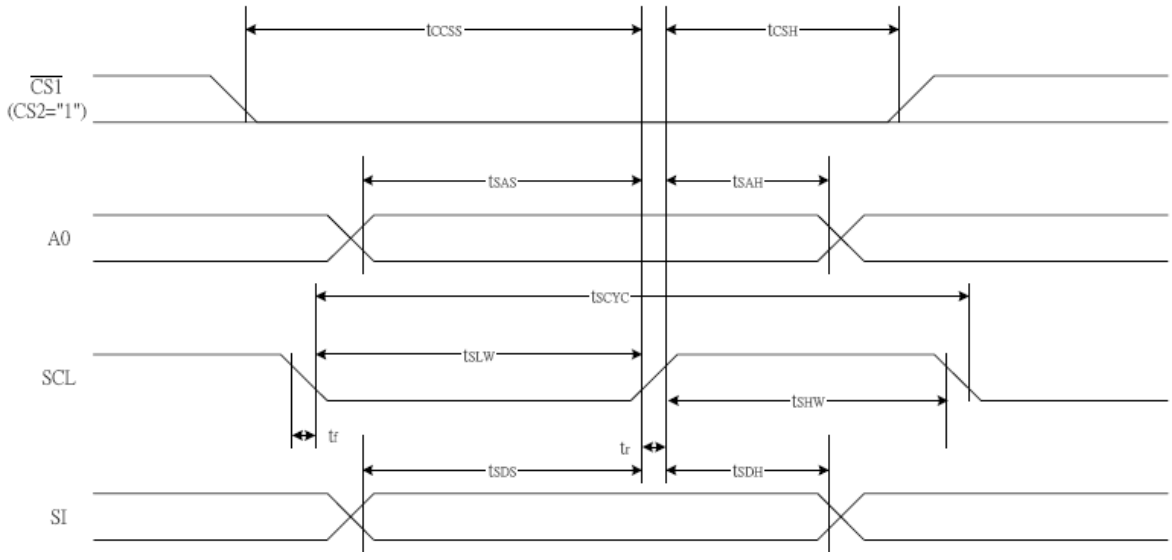


Figure 2.2 SPI Timing

2.4 Control Commands

AD-12864-SPI LCD module has 22 commands. Users also can refer ST7605 datasheet.

Note, A0P is A0.

2.4.1 Display On/Off

A0P	EP $\overline{RD}$	RWP $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Setting
0	1	0	1	0	1	0	1	1	1	1	Display ON
										0	Display OFF

2.4.2 Display Start Line Set

This command is used to specify the display start line address of the display data RAM.

A0P	EP $\overline{RD}$	RWP $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Line Address
0	1	0	0	1	0	0	0	0	0	0	0
					0	0	0	0	0	1	1
					0	0	0	0	1	0	2
							↓				↓
					1	1	1	1	1	0	62
					1	1	1	1	1	1	63

2.4.3 Page Address Set

A0P	EP $\overline{RD}$	RWP $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Page Address
0	1	0	1	0	1	1	0	0	0	0	0
							0	0	0	1	1
							0	0	1	0	2
									↓		↓
							0	1	1	1	7
							1	0	0	0	8

2.4.4 Column Address Set

This command specifies the column address of the display data RAM. The column address is split into two sections (the higher 4 bits and the lower 4 bits) when it is set (fundamentally, set continuously), As Table 2.2, if DB4 is 0, lower 4 bit has been set, and DB4 is 1, Higher has done.

Table 2.2 Colunm Address Set Command

A0P	EP $\overline{RD}$	RWP $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	A7	A6	A5	A4	A3	A2	A1	A0	Column Address
0	1	0	0	0	0	1	A7	A6	A5	A4	0	0	0	0	0	0	0	0	0
						0	A3	A2	A1	A0	0	0	0	0	0	0	0	1	1
											0	0	0	0	0	0	1	0	2
															↓				↓
											1	0	0	0	0	0	0	0	130
											1	0	0	0	0	0	1	1	131

2.4.5 Read Status

A0P	EP $\overline{RD}$	RWP $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	BUSY	ADC	ON/OFF	$\overline{RESET}$	0	0	0	0

BUSY	BUSY = 1: it indicates that either processing is occurring internally or a reset condition is in process. BUSY = 0: A new command can be accepted. if the cycle time can be satisfied, there is no need to check for BUSY conditions.
ADC	This shows the relationship between the column address and the segment driver. 0: Normal (column address n ↔ SEG n) 1: Reverse (column address 131-n ↔ SEG n) (The ADC command switches the polarity.)
ON/OFF	ON/OFF: indicates the display ON/OFF state. 0: Display ON 1: Display OFF (This display ON/OFF command switches the polarity.)
RESET	This indicates that the chip is in the process of initialization either because of a /RES signal or because of a reset command. 0: Operating state 1: Reset in progress

2.4.6 Display Data Write

This command writes 8-bit data to the specified display data RAM address. The column address is automatically incremented by "1" after the write.

A0P	$\overline{EP}$ $\overline{RD}$	$\overline{RWP}$ $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	1	0	Write data							

2.4.7 Display Data Read

This command reads 8-bit data from the specified display data RAM address. The column address is automatically incremented by "1" after the read.

Note, when the serial interface is used, reading of the display data becomes unavailable.

A0P	$\overline{EP}$ $\overline{RD}$	$\overline{RWP}$ $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	1	Read Data							

2.4.8 ADC Select(Segment Driver Direction Select)

This command can reverse the correspondence between the display RAM data column address and the segment driver output. Thus, sequence of the segment driver output pins may be reversed by the command.

A0P	$\overline{EP}$ $\overline{RD}$	$\overline{RWP}$ $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Setting
0	1	0	1	0	1	0	0	0	0	0	Normal
										1	Reverse

2.4.9 Display Normal/Reverse

This command can reverse the lit and unlit display without overwriting the contents of the display data RAM. When this is done the display data RAM contents are maintained.

A0P	EP $\overline{RD}$	RWP $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Setting
0	1	0	1	0	1	0	0	1	1	0	RAM Data 'H' LCD ON voltage (normal
										1	RAM Data 'L' LCD ON voltage (reverse)

2.4.10 Display All Points ON/OFF

This command makes it possible to force all display points ON regardless of the content of the display data RAM. The contents of the display data RAM are maintained when this is done. This command takes priority over the display normal/reverse command.

A0P	EP $\overline{RD}$	RWP $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Setting
0	1	0	1	0	1	0	0	1	0	0	Normal display mode
										1	Display all points ON

2.4.11 LCD Bias Set

This command selects the voltage bias ratio required for the liquid crystal display.

A0P	EP $\overline{RD}$	RWP $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Select Status
0	1	0	1	0	1	0	0	0	1	0	1/9 bias
										1	1/7 bias

2.4.12 Read/Modify/Write Mode Set

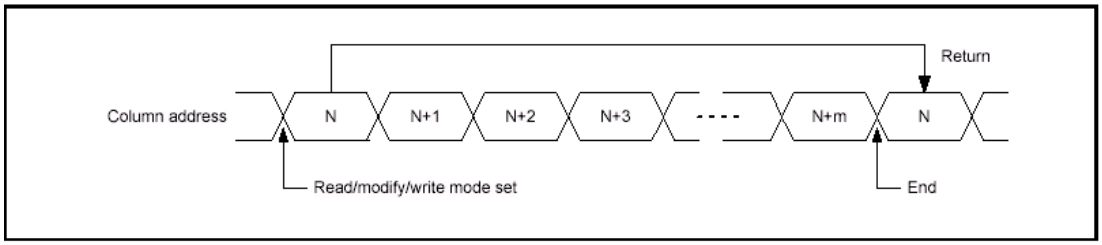
This command is used paired with the "END" command. Once this command has been input, the display data read command does not change the column address, but only the display data write command increments (+1) the column address. This mode is maintained until the END command is input. When the END command is input, the column address returns to the address it was at when the read/modify/write command was entered. This function makes it possible to reduce the load on the MCU when there are repeating data changes in a specified display region, such as when there is a blanking cursor.

A0P	EP $\overline{RD}$	RWP $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	0	1	1	1	0	0	0	0	0

2.4.13 Read/Modify/Write Mode End

This command releases the read/modify/write mode, and returns the column address to the address it was at when the mode was entered.

A0P	EP /RD	RWP /WR	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	0	1	1	1	0	1	1	1	0



2.4.14 Reset

This command initializes the display start line, the column address, the page address, the common output mode, and the read/modify/write mode and test mode are released. There is no impact on the display data RAM.

A0P	EP /RD	RWP /WR	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	0	1	1	1	0	0	0	1	0

2.4.15 Common Output Mode Select

This command can select the scan direction of the COM output terminal.

A0P	EP /RD	RWP /WR	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Select Status
0	1	0	1	1	0	0	0	-	-	-	Normal COM0 → COM63
							1				Reverse COM63 → COM0

2.4.16 Power Controller Set

A0P	EP /RD	RWP /WR	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Selected Mode
0	1	0	0	0	1	0	1	0			Booster circuit: OFF
								1			Booster circuit: ON
									0		Voltage regulator circuit :OFF
									1		Voltage regulator circuit: ON
										0	Voltage follower circuit: OFF
										1	Voltage follower circuit: ON

2.4.17 V5 Voltage Regulator Internal Resistor Ratio Set

A0P	EP /RD	RWP /WR	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Setting
0	1	0	0	0	1	0	0	0	0	0	Small
								0	0	1	
								0	1	0	
									↓		↓
								1	1	0	
								1	1	1	Large

2.4.18 Electronic Volume Mode Set

This is a double byte command, it used to adjust the brightness of the liquid crystal display. Table 2.3 is electronic volume mode set command, and Table 2.4 is electronic volumn register set.

Table 2.3

A0P	EP $\overline{RD}$	RWP $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	0	1	0	0	0	0	0	0	1

Table 2.4

A0P	EP $\overline{RD}$	RWP $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	| Vs|
0	1	0	*	*	0	0	0	0	0	1	Small
0	1	0	*	*	0	0	0	0	1	0	
0	1	0	*	*	0	0	0	0	1	1	
						↓					↓
0	1	0	*	*	1	1	1	1	1	0	
0	1	0	*	*	1	1	1	1	1	1	Large

The electronic volume register can be set as shown in Figure 2.3.

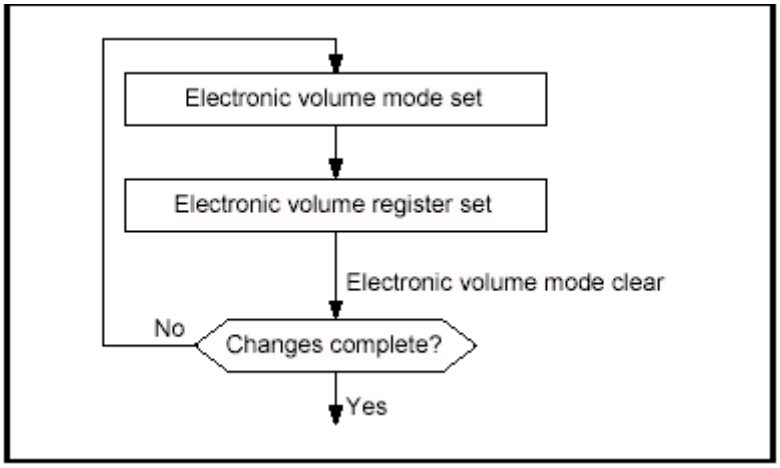


Figure 2.3 Electronic volume register set

2.4.19 Static Indicator

This command controls the static drive system indicator display. It is another double byte command.

Table 2.5 Static Indicator ON/OFF

A0P	EP $\overline{RD}$	RWP $\overline{WR}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Static Indicator
0	1	0	1	0	1	0	1	1	0	0	OFF
										1	ON

Table 2.6 Static Indicator Register Set

A0P	EP / RD	RWP / WR	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Static Indicator
0	1	0	*	*	*	*	*	*	0	0	OFF
			*	*	*	*	*	*	0	1	ON (blinking at approximately 0.5 second intervals)
			*	*	*	*	*	*	1	0	ON (blinking at approximately one second intervals)
			*	*	*	*	*	*	1	1	ON (constantly on)

2.4.20 Power Save Mode

When the display all points ON is performed while the display is in the OFF mode, the power save mode is entered, thus greatly reducing power consumption. The power saver mode has two different modes: the sleep mode and the standby mode. When the static indicator is OFF, it is the sleep mode that is entered. When the static indicator is ON, it is the standby mode that is entered. In the sleep mode and in the standby mode, the display data is saved as is the operating mode that was in effect before the power save mode was initiated, and the MCU is still able to access the display data RAM.

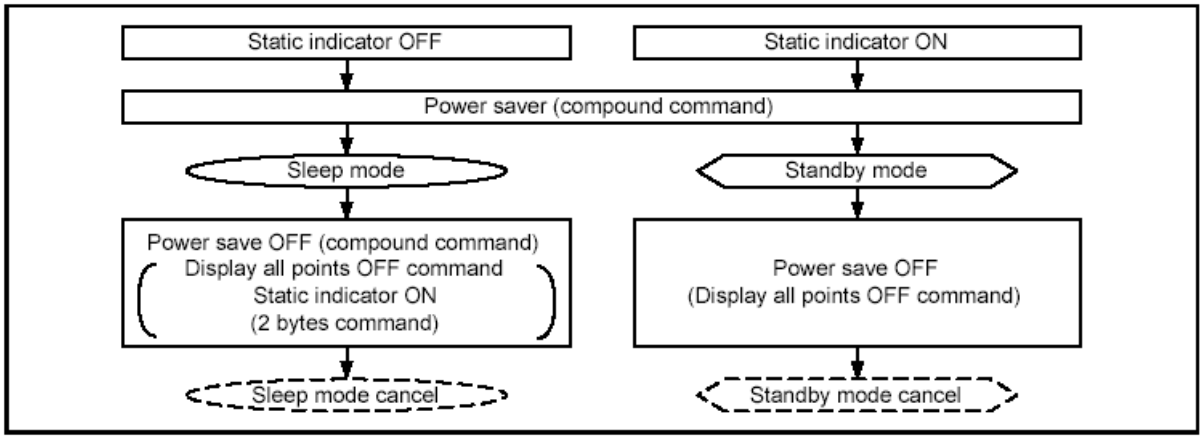


Figure 2.4 Power Save Processing

Sleep mode

This stops all operations in the LCD display system, and as long as there are no accesses from the MPU, the consumption current is reduced to a value near the static current.

Standby mode

The duty LCD display system operations are halted and only the static drive system for the indicator continues to operate, providing the minimum required consumption current for the static drive.
When a reset command is performed while in standby mode, the system enters sleep mode.

3 Sample Source Code

The following are examples AD-12864-SPI LCD module controlled by different MCU.

3.1 AD-12864-SPI LCD Driver Code Based On MCS51

The mainly application programming interface function including write data, write command, and read data is shown as follow.

```
#include "REG51.h"
#include "intrins.h"

sbit LCD_CS    =        P0^7;
sbit LCD_RES =          P0^6;
sbit LCD_A0    =        P0^5;
sbit LCD_CLK =          P0^4;
sbit LCD_SDI =          P0^3;
//=============================================================================
// Function name:   void LCD_DataWrite(unsigned int Data)
// Description:     Write 1 byte date to display RAM
// Parameters:      Write data
// Return:          None
// Comments:        None
// Version:
//        2007/05/17        First version
//=============================================================================
void LCD_DataWrite(unsigned char Dat)//,_Fill_Dot_LCD
{
        unsigned char Num;
        LCD_CS = 0;
        LCD_A0 = 1;
        for(Num=0;Num<8;Num++)
        {
            if((Dat&0x80) == 0)   LCD_SDI = 0;
            else LCD_SDI = 1;
            Dat = Dat << 1;
            LCD_CLK = 0;
            LCD_CLK = 1;
        }
        LCD_CS = 1;
```

```
}
//=============================================================================
// Function name:   void LCD_RegWrite(unsigned char Command)
// Description:     Write 1 byte data to control register
// Parameters:      Command, write data
// Return:          None
// Comments:        None
// Version:
//       2007/05/17        First version
//=============================================================================
void LCD_RegWrite(unsigned char Command)
{
        unsigned char Num;
        LCD_CS = 0;
        LCD_A0 = 0;
        for(Num=0;Num<8;Num++)
        {
            if((Command&0x80) == 0)LCD_SDI = 0;
            else LCD_SDI = 1;
            Command = Command << 1;
            LCD_CLK = 0;
            LCD_CLK = 1;
        }
        LCD_CS = 1;
}
```

Users can refer to following code to write LCD initial function.(*Recommended)

```
//=============================================================================
// Function name:   void LCD_Init(void)
// Description:     LCD initial function. Users can refer to ST7565 datasheet for more information
// Parameters:      None
// Return:          None
// Comments:        None
// Version:
//              2006/10/15          First version
//              2007/01/09          V1.2
//=============================================================================
//Delay
void TimeDelay(int Time)
```

```
{
        int i;
        if(Time > 0)
        {
            for(i = 0;i < 800;i++)
            {
            }
            Time --;
        }
}
void LCD_Init(void)
{
        //Initial all of port LCD driver use(if necessary)
        //    LCD_PortInit();
        TimeDelay(200);
        LCD_RS = 0;
        TimeDelay(200);
        LCD_RS = 1;

        LCD_RegWrite(0xaf);                     // LCD On
        LCD_RegWrite(0x2f);                     // Set power control mode

        LCD_RegWrite(0x81);                     // Set electronic volume mode
        LCD_RegWrite(0x1f);                     // Command data 0x0000~0x003f

        LCD_RegWrite(0x27);                     // Set V5 internal voltage adjustment resistor
        LCD_RegWrite(0xa2);                     // Set LCD bias

        LCD_RegWrite(0xc8);                     // Com scan direction set, reverse
        LCD_RegWrite(0xa0);                     // Select segment direction, normal
        LCD_RegWrite(0xa4);                     // Set all point ON/OFF command
        LCD_RegWrite(0xa6);                     // Set normal/reverse display command

        LCD_RegWrite(0xac);                     // Close static indicator
        LCD_RegWrite(0x00);                     // Command data

        LCD_RegWrite(0x40 +0);                  // Set start common RAM
        LCD_RegWrite(0xe0);                     // Set read/write mode
}
```

4 Sales and Design Support

AKIHABARA INC. is a prefessional LCD module design company, has rich experience in LCD driver and LCD driver firmware, designs many good portability program. Besides, we will design more and better driver code to accommodate different use.

And, we will give more reference to HMI design, or specializes customer order. Users would get perfect products, and prefessional technical support.

Perfect products and prefessional technical support is our long-term and most important aims.

Users would get sales and design support by following information.

- Email： info@akiba-tech.com
- WebSite： http://www.aitendo.co.jp